Direct arterial pressure, pulse rate, and electrocardiogram during micturition and defecation in unrestricted man

W. A. Littler, M.D., M.R.C.P.
A. J. Honour, M.A., D.Phil.
P. Sleight, M.D., F.R.C.P.
Oxford, England

Micturition and defecation may be associated with dramatic cardiovascular events such as syncope and collapse due to pulmonary embolism. Little is known about the changes in arterial pressure or heart rate which accompany normal excretory events.

In paraplegic patients, increased arterial pressure, sweating, and skin vasoconstriction have been shown to accompany bladder filling and rises in intravesical pressure.[1-3] The decrease in skin blood flow was attributed to active vasoconstriction as a result of a spinal reflex. Corbett and colleagues[4] further demonstrated that bladder percussion produced contraction of the wall of the bladder and this was associated with increased arterial pressure, decreased heart rate, and calf and hand blood flow. These responses occurred whether there was a rise in intravesical pressure or not.

It was therefore of interest to study the circulatory changes associated with normal excretory events during measurement of blood pressure and electrocardiogram over 24 hours in ambulent subjects outside hospital.

Patients and methods

Eleven patients who had accurately indicated the time of micturition and defecation were chosen from a larger group in whom direct arterial pressure, heart rate, and electrocardiogram have been recorded continuously over a 24-hour period. Their details are listed in Table I. All patients gave informed consent to the study, in which the methods used have been previously described.[5] The patients were studied over a 24-hour period from 9.00 A.M. to 9.00 A.M. During this time they attended the laboratory only once for 15 minutes after a 12-hour interval, to calibrate and service the apparatus. Significant events were recorded simultaneously on the tape and in a diary kept by the patient.

After preliminary inspection of our results, each selected event was played out so that a visual beat-to-beat analysis could be achieved. The records were also scrutinized for changes in cardiac rhythm and ST segment shift.[6]

Results

A total of 35 episodes were clearly indicated by 11 patients; these consisted of 25 episodes of micturition and 10 episodes of defecation (one in each patient apart from Case 4).

The characteristic pattern of cardiovascular response observed, irrespective of whether the subject micturated or defecated, was essentially a Valsalva maneuver [7] (Tables II and III). Fig. 1 is a typical example from a 27-year-old schoolteacher who developed systemic hypertension while taking oral contraceptives. With the onset of micturition there was a brief rise in arterial pressure followed by a precipitous fall to a level of 108/82 mm. Hg, when it rose to an alarming 282/169 mm. Hg with the overshoot. Reflex bradycardia occurred during the overshoot period, widening the RR interval from 0.69 second at the beginning to 1.0 second. This Valsalva pattern was observed in varying degree during micturition in 21

From the Departments of Cardiovascular Medicine and the Regius Professor of Medicine, Radcliffe Infirmary, Oxford, England.

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Reprint requests to: Dr. W. A. Littler, Department of Cardiovascular Medicine, Radcliffe Infirmary, Oxford, England.

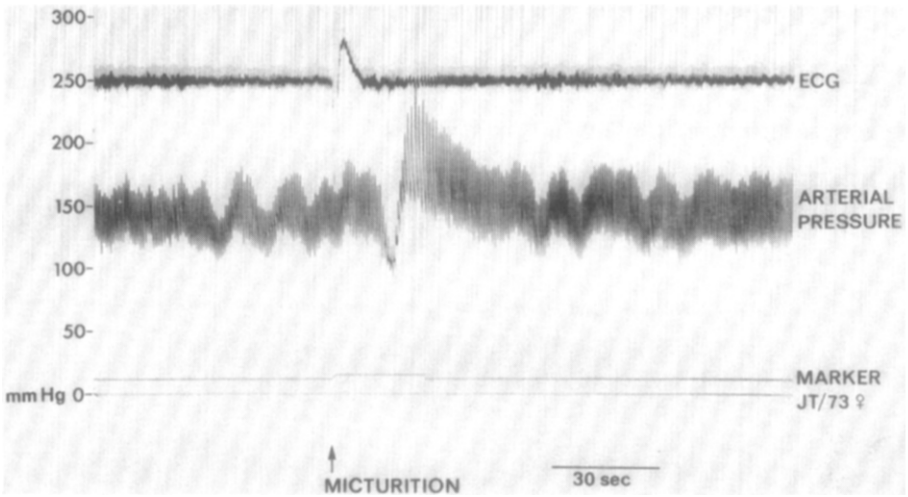

Fig. 1. A tracing from a 27-year-old woman who developed hypertension while taking oral contraceptives (Case 3). Note that the predominant changes in arterial pressure are those of a Valsalva response (see text) with reflex slowing of the heart during the "overshoot" period.

Table I. Patient data

Patient	*Age (yr.)*	*Sex*	*Occupation*	*Diagnosis*	*Treatment*	*Resting BP*
1.	50	M	Doctor	Essential hypertension	—	140/100
2.	20	M	Factory worker	Normotensive	—	120/70
3.	23	F	Teacher	Hypertension (Pill)	—	180/115
4.	35	M	Doctor	Normal	—	136/84
5.	33	F	Psychologist	Normal	—	110/70
6.	22	F	Teacher	Essential hypertension	Propranolol 80 mg. daily, Aldactide 400 mg.	150/110
7.	39	F	Housewife	Renal hypertension	Bethanidine 20 mg. tds	180/115
8.	54	M	Engineer	Angina	Propranolol 80 mg. tds, Glyceryl trinitrate	125/75
9.	55	M	Factory worker	Pheochromocytoma	—	220/130
10.	20	M	Student	Normal	—	138/82
11.	62	F	Housewife	Essential hypertension, angina	Methyl dopa 750 mg., Practolol 300 mg., Glyceryl trinitrate, Digoxin 0.25 mg.	200/85

out of the 25 events (86 per cent). It did not occur in Case 7, a woman with renal hypertension receiving bethanidine, or Case 11, a 62-year-old woman with hypertension and angina receiving methyldopa and practolol. In these two patients there was little initial fall in arterial pressure and no overshoot or reflex bradycardia.

There were no real quantitative differences between the magnitude of the response in males and females, although the largest overshoot, +174/82 mm. Hg, was in a female (Case 3, Table II). In men, the Valsalva maneuver tended to be repeated several times during micturition with a diminishing response (Fig. 2), while the females, in general, showed one major response (Fig. 1). A single Valsalva response extended over 25 to 40 seconds.

Fig. 3 demonstrates that the arterial pressure after micturition did not show any consistent or significant rise or fall as compared with the level before micturition.

During defecation, a similar Valsalva response was observed and often repeated several times. Fig. 4 is a record of defecation in the young

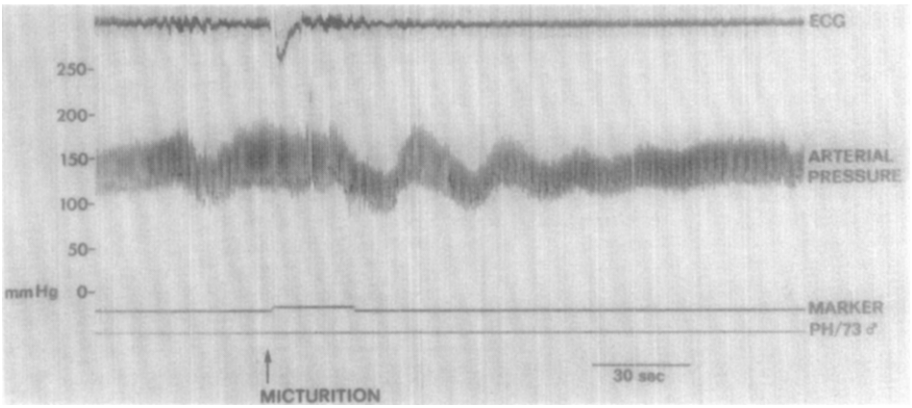

Fig. 2. Micturition in a hypertensive man showing at least 3 "troughs and peaks" of arterial pressure during the event before the pressure evens out (Case 1).

Table II. Micturition (25 events)*

Case	*Arterial pressure*			*R-R control (sec.)*	*R-R overshoot (sec.)*	*Duration (sec.)*
	Control (mm. Hg)	*Trough (mm. Hg)*	*Overshoot (mm. Hg)*			
1.	180/110	128/86	175/120	0.89	1.14	40
	136/86	114/73	192/86	0.89	1.14	40
2.	68/43	36/22	88/63	0.69	0.8	40
	140/83	60/39	170/87	0.69	0.8	30
	137/100	106/87	133/103	0.69	0.8	40
3.	133/85	76/51	148/109	0.7	0.9	30
	133/100	123/97	164/121	0.69	0.8	30
4.	90/50	67/35	115/65	0.69	1.14	40
	90/50	85/50	104/55	1.09	1.09	30
5.	83/59	72/41	103/60	0.62	0.69	30
6.	133/85	70/51	148/108	0.69	1.3	30
	133/100	133/97	164/121	0.9	1.4	30
7.	123/100	113/100	128/95	0.69	0.69	25
	130/97	127/95	127/95	0.7	0.69	30
8.	105/77	80/62	113/88	0.8	1.03	40
	110/80	100/72	120/95	1.03	1.03	31
9.	168/104	150/90	202/125	0.60	0.69	40
	164/125	122/82	167/125	0.69	0.80	40
	166/100	140/80	212/110	0.70	1.03	45
10.	116/94	109/89	132/97	0.45	0.69	28
	122/97	98/74	129/94	0.50	0.83	30
	116/93	91/70	120/93	0.69	1.08	45
	137/83	119/70	137/90	0.69	1.03	40
11.	238/117	202/117	190/112	0.69	0.69	40
	212/127	193/120	175/127	0.8	0.80	40

*A summary of the most significant cardiovascular changes during each micturition event (see text).

woman whose response to micturition is shown in Fig. 1. The responses are clearly similar. Fig. 5 is taken from a normotensive male patient and shows a Valsalva response towards the end of defecation. This pattern was observed in normal, hypertensive, and angina patients, irrespective of their treatment.

Discussion

There are rich reflex interconnections between the bladder and cardiovascular system, but little attention has been paid to the behavior of arterial pressure and heart rate in man during micturition with the bladder intact. In mammals, the basic cardiovascular response to bladder disten-

Table III. Defecation (10 events)

Case	Arterial pressure			R-R control (sec.)	R-R overshoot (sec.)	Duration (sec.)
	Control (mm. Hg)	Trough (mm. Hg)	Overshoot (mm. Hg)			
1.	142/100	125/90	167/114	0.89	1.14	40
2.	150/93	70/39	180/97	0.69	0.8	30
3.	130/70	116/59	212/132	0.60	1.03	40
4.	—	—	—	—	—	—
5.	81/55	59/35	93/61	0.62	0.69	30
6.	123/85	90/61	157/102	0.69	1.03	32
7.	114/90	95/77	136/100	0.69	0.69	40
8.	105/77	80/62	113/88	0.69	0.88	48
9.	154/108	118/82	146/110	0.69	0.69	50
10.	103/89	85/70	116/96	0.69	1.40	28
11.	218/152	175/140	240/165	0.69	1.03	40

*A summary of the changes during defecation.

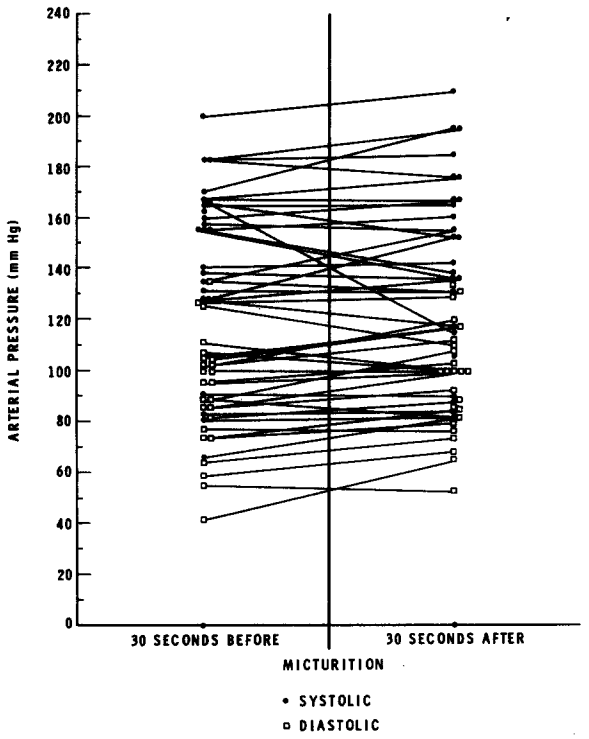

Fig. 3. Blood pressure readings averaged over 10 beats, 30 seconds before starting and 30 seconds after micturition in both females and males. There is no significant alteration in the levels of either systolic or diastolic pressure.

tion appears to be vasoconstriction with an accompanying rise in blood pressure. These observations have been made mostly under laboratory conditions, where the bladder was deliberately distended.[1-3]

Muellner[8] believes that the initiation of micturition is not brought about only by impulses to the bladder, but that man develops a voluntary mechanism which is mediated through the use of the intra-abdominal pressure and his pelvic floor muscles. Furthermore, he believes that the direction of intra-abdominal pressure towards the vesical neck to initiate the reflexes of voluntary micturition is not normally a straining effort. However, the respiratory maneuver associated with micturition suggests it may sometimes involve forceful expiration against a closed glottis.[7] Proudfit and Forteza[9] believe that a Valsalva maneuver is performed at the beginning and at the termination of micturition; our findings, especially in women, lend support to this hypothesis.

Our patients were allowed complete freedom during the study and the events reported there were clearly marked, although we obviously were not able to ascertain how distended their bladders were at that time. The most characteristic pattern in the female, illustrated in Fig. 1, shows the initial rise, fall, and subsequent rise in arterial pressure with an associated reflex bradycardia—i.e., a typical Valsalva maneuver. Micturition in the female usually takes place in the squatting position, which may involve "strain." Alternatively, there might be a general vasoconstriction induced through autonomic reflexes by a distended bladder, which disappears with bladder emptying and is followed by temporary hypotension. However, we have seen neither a big increase or a significant fall in arterial pressure occurring before or after micturition. In males especially, the "peak and trough" effect of the arterial pressure is repeated several times

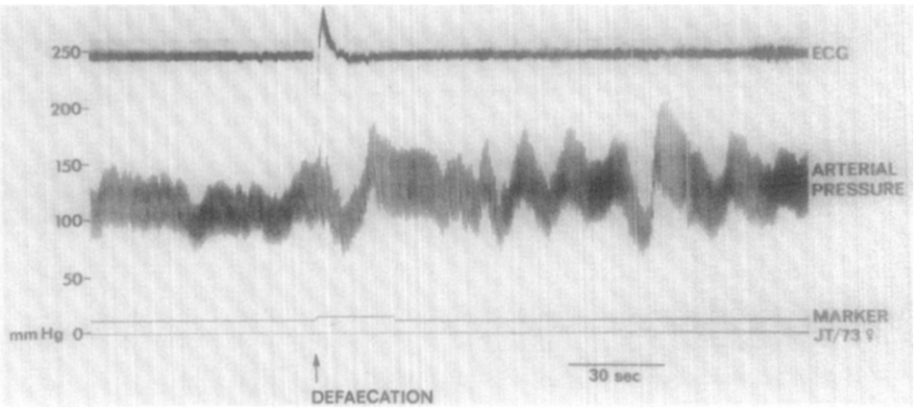

Fig. 4. Defecation (Case 3). The arterial pressure trace shows at least four Valsalva responses during this event (compare with Fig. 1).

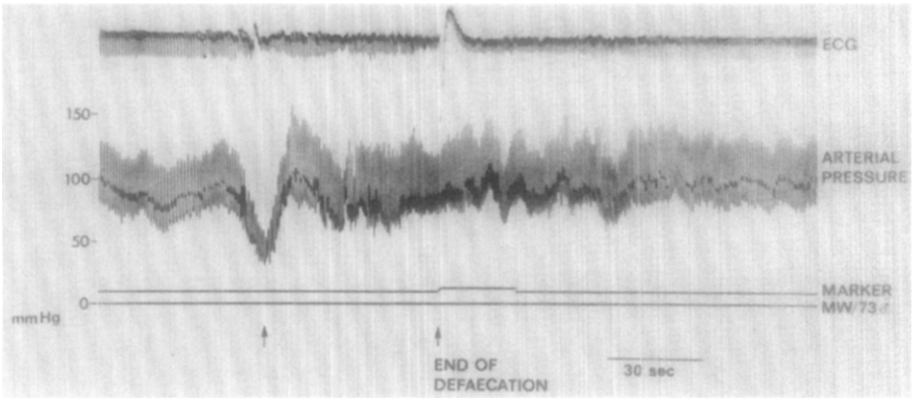

Fig. 5. Defecation in a normotensive male (signal indicates end of event in this instance). The most significant change in arterial pressure (*arrows*) is a typical Valsalva response (Case 2).

during micturition, suggesting that these may well be associated with straining (Fig. 2). Males micturate in a standing position, unless associated with defecating, and straining movements are often repeated, possibly explaining the cardiovascular changes observed.

Micturition syncope is believed by some investigators to be associated with the circulatory effects of the Valsalva maneuver.[9] However, this hypothesis is not shared by all.[10] Our observations certainly indicate dramatic circulatory changes during micturition but do not show any substantial fall afterwards as occurs with a spinal bladder.[3]

It is well recorded that defecation is accompanied by the Valsalva maneuver, with the characteristic cardiovascular changes.[7] However, this work does not state the total number of observations made or the types of patient who were studied. The main cardiovascular feature during defecation in our patients was a Valsalva response, often repeated several times during the event (Fig. 4).

Patients, whether normotensive or hypertensive, showed no qualitative differences, although responses could have been altered by drug therapy in two patients, but numbers were too small to come to any definite conclusion.

Our results indicate that very large swings in the level of arterial pressure and heart rate occur during everyday life without the patient being at all aware of them. It is surprising, in view of some of our figures, that subarachnoid and cerebral hemorrhage does not occur more frequently during excretion than at other times.

Summary

Eleven unrestricted patients clearly indicated episodes of micturition and defecation during a 24-hour period when their arterial pressure,

heart rate, and electrocardiogram were recorded continuously.

During excretory events in both males and females, the predominant cardiovascular change was a Valsalva maneuver, which in some instances was repeated several times.

There was no significant change in the level of arterial pressure following micturition as compared with the level beforehand.

These cardiovascular changes were uninfluenced by the presence of essential hypertension or ischemic heart disease, but were modified in some instances by drugs which affected the autonomic nervous system.

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